Week 6
CHE 3331- Organic Chemistry

This week is <u>Week</u> <u>6</u> <u>of class</u>**, and typically in this week of the semester, your professors are covering these topics below.** If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout of the semester.

We also invite you to **look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester**.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours. M-Th 9am-8pm on class days 254-710-4135.

Keywords: Priority, Fischer Projections, Enthalpy, Endothermic, Exothermic, Gibbs Free Energy
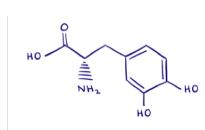
TOPIC OF THE WEEK: REVIEW OF STEREOISOMERS AND ASSIGNING PRIORITY

Last week, we covered how to assign priority to a chiral molecule. (Remember, a chiral molecule is a carbon attached to *four different groups*!)

- Step 1: identify all four atoms attached to the chiral carbon
- Step 2: Assign highest priority based on the highest atomic number!
    - Remember, your lowest atomic number, hydrogen, will always receive a 4 priority
    - If two atoms have the same atomic number (like a chiral carbon directly attached to 2 other carbons), move away from the chiral carbon center to identify which atom will be the tie breaker
- Step 3: Your 4th priority should always be on a dash! So, if your 4th priority is on a wedge, then flip your answer.
    - For example, if your 4th priority is on a wedge and you identified it as R, then your answer will be S. o R = clockwise o S = counterclockwise
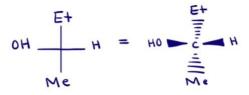
Practice #1: Practice assigning priority to each of the following molecules and identify its configuration (R or S).

1.

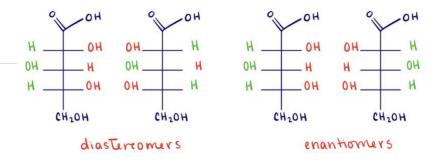<p style="text-align:center">HIGHLIGHT #1: Drawing Fischer Projection</p>

- It might take some time to understand how to read and draw Fischer projections, but I promise, it is not as hard as it may seem.
  - o For each chirality center, the horizontal lines are meant to be drawn as coming out of the page while the vertical lines are going into the page.
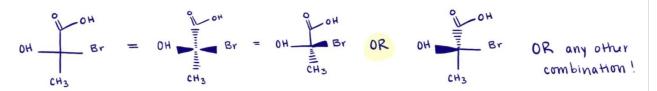

  - o Fisher projections were made because they can readily help identify which compounds are diastereomers or enantiomers!
    - ▪ If all chirality centers have the opposite configuration, then they are enantiomers.
    - ▪ If all but one chirality center has the opposite configuration, then they are diastereomers.
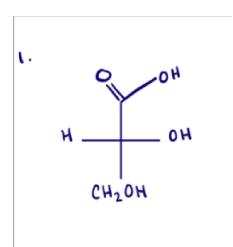

- Oftentimes, you will be asked to assign configurations to chirality centers on a Fischer projection! Many students get confused with doing this because they have

never assigned priority with 2 dashes and 2 wedges. We normally only have 1 dash and 1 wedge.

- So, what you can do is pick only one atom within a horizontal line to carry a wedge and draw the other one as a straight line. Then, do the same thing with the vertical line. Pick only one atom and draw it as a dash and draw the other one as a straight line. **Your answer will still be the same regardless of which one you pick!**
- For the bottom example, you will note how first, we draw all horizontal lines on a wedge and all vertical on a dash. Then from there, you can pick any combination of dashed or wedges that you would like as long as you pick **ONE dash and ONE wedge from each vertical and horizontal line, respectively.**

Practice #2: Let's practice getting more comfortable with assigning priority and determining configurations of chirality centers with Fischer projections! For all the following, determine the configuration of each chiral carbon and once you have done that, draw an enantiomer for each molecule!
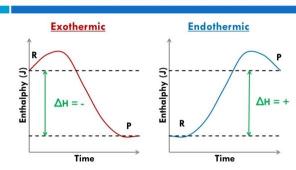

1.

HIGHLIGHT #2: Enthalpy, Entropy, and Gibbs Free Energy

Now, we will be moving onto more Chapter 6 material, which covers chemical reactivity and how heat affects reactions!

- **Enthalpy** is a value that is used to measure change in energy. You may remember from General Chemistry that the value for enthalpy is ΔH
- A $+ \Delta H$ means that the reaction is endothermic, which means that energy needs to be put *into* the system for that reaction to occur.
- For example, breaking a bond is an **endothermic process**. Let's say we have a C-C bond. That bond is stable and is fine how it is, however, if we want to break it, then

we need to put energy IN to do that. *Whatever is stable by itself will need outside energy to be broken!*
- A – ΔH means that the reaction is exothermic, which means that whatever occurred in the reaction *released* energy!
- In addition to the previous example, forming a bond is an **exothermic reaction**. If 2 atoms want to be together, then bringing them together is most favorable, which does not require energy.

- These are the graphs for an exothermic and endothermic reaction

Reaction Coordinate Diagrams

Exothermic	Endothermic

ΔH = -   ΔH = +

- For the first graph which represents an exothermic reaction, think of it similarly as walking down the stairs. I think we can all agree that walking down the stairs is much easier than walking up the stairs. So, walking down the stairs would represent a release in energy! *You don't need to put much energy into walking down the stairs, right?* For that reason, the product is much lower in enthalpy than the reactant!
- For the second graph, which is an endothermic reaction, think of it as walking up the stairs. This takes much more energy which is why the product is HIGHER in energy than the reactants! The product will only occur if put in energy into it!

1. **Entropy** is another value that is going to help us understand the principles that guide all thermodynamic processes. Entropy is a variable that measures the disorder within a system or reaction and is represented by the variable ΔS.
   - A + ΔS means that there is an increase in entropy, which means that there is an increase in disorder.
   - For our purposes, you can think of disorder as whether a bond is breaking or forming.
   - *If we are breaking a bond, we are increasing the disorder within the system*
   - *If we are forming a bond, we are "cleaning up" the reaction or making it neater, which decreases the entropy in the system.*
   - A – ΔS means that there is a decrease in entropy, which means that there is a decrease in the disorder within a molecule.

2. Lastly, if we put all of these variables together, we get the Gibbs Free energy equation, which will ultimately tell us if our reaction will be spontaneous or not.
   - The equation for Gibbs Free Energy is as follows:

ΔG = ΔH (enthalpy) + (-T (temperature) x ΔS)

- For the reaction to be spontaneous, ΔG must be negative. So we are ultimately looking for an ideal reaction, where   o Enthalpy will be a large **negative** value (which means the reaction is exothermic)   o Temperature will be the highest (remember the negative sign!)
  o Entropy will also a large **positive** value (positive because the negative sign from the temperature will be foiled into it. If we have a negative value for entropy and we multiply it times a large negative value for temperature, we will have a large positive value! Since we are looking for the most negative value for ΔG, this will not be ideal.

HIGHLIGHT #3: Kinetics

Previously, we have been discussing entropy, enthalpy, and Gibbs Free energy, which are all variables that depict heat transfer and temperature within a reaction. But now we are transitioning over to the kinetics of a reaction! Note this distinction because it will be important.

- The rate of an equation is described with the following **general** formula:

$$\text{Rate} = k \, [\text{Reactants}]$$

- Where **k is the rate constant** which tells us the rate at which the reaction will occur
- The concentration of the reactions is important to the rate constant because **if we increase the number of reactants**, we are increasing the amount of molecules that are reacting and colliding against one another, which **increases the rate of the reaction.**

- In the rate equation, we must also show the concentration of our reactants by adding exponents! However, *we can achieve different rates of the reaction by doubling the concentration of certain reactants in the reaction*! The sum of the exponents in the rate reaction is directly equal to the order of that reaction. (If the sum of exponents is 2, theni t is a second order reaction)
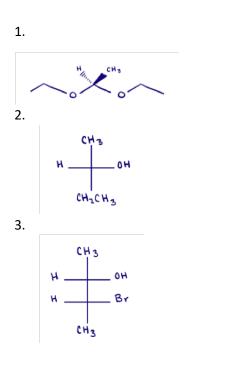
$\text{Rate} = k \, [A]$ | $\text{Rate} = k \, [A][B]$ | $\text{Rate} = k \, [A]^2[B]$
First order reaction | Second order reaction | Third order reaction

- In a first order reaction, there is only one reactant, A. So if we double the concentration of A, then the rate will also double. But if we double the concentration of B, then it will have no effect on the reaction at all.
- In the second order reaction, we have two reactants present in the reaction, A and B. If we double the concentration of either A **or** B, the rate will double also. So in this case, both reactants are written in the rate expression, which makes it a second order reaction.

- In the third order reaction, if we double the concentration of A, then it will *quadruple* the rate of the reaction, which is what makes this a third order reaction.

- Note, that **there are a few things that can affect the rate constant**!
  - **The energy of activation of a reaction**
    - The activation energy, E_a, is the minimum amount of energy that is needed for the reaction to occur. Think of this as a threshold that we need to get over so that the reaction can occur. If the threshold is very high, then we will need a lot of energy to get over it, but if the threshold is low, then we will need little energy to get over it!
  - **An increase in temperature will increase the rate of reaction!**

<p align="center">CHECK YOUR LEARNING:</p>

1.

2.

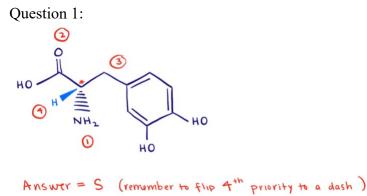

3.

<p align="center">THINGS YOU MAY STRUGGLE WITH:</p>

1. The terms enthalpy and entropy are very commonly confused! Make sure that you understand what both words mean, the variable they represent, and how increasing or decreasing either would affect a relationship. This is fundamental to chemistry, so make sure that you don't confuse these terms!
2. Make sure you do not neglect the energy diagrams! Looking at them and understanding what they mean is very important! Spend some time this week looking at the diagrams in your book to make sure you understand what it is saying and can differentiate between an endothermic graph vs. an exothermic graph!
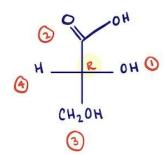
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ANSWERS TO PRACTICES 1-2:

Question 1:

Answer = S (remember to flip 4th priority to a dash)

Question 2:

Thanks for checking out these weekly resources!
Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring ! Answers to check your learning questions are below!

You can also check out the tutoring website for videos explaining concepts in Ochem-1:
https://www.baylor.edu/case/index.php?id=978624

ANSWERS TO CHECK YOUR UNDERSTANDING:

Question   1:

trick question! No chiral carbon!

Question   2:

Question   3: